

## NEPTUNE.

## Observations.

## HAMBURG. Meridian Circle. (M. Rümker.)

| 1847.   | Hamburg M.T.                           | R.A.                                   | N.P.D.                                 |
|---------|----------------------------------------|----------------------------------------|----------------------------------------|
|         | <sup>h</sup> <sup>m</sup> <sup>s</sup> | <sup>o</sup> <sup>'</sup> <sup>"</sup> | <sup>o</sup> <sup>'</sup> <sup>"</sup> |
| Oct. 12 | 8 37 44.0                              | 330 11 54.3                            | 102 48 32.3                            |
| 14      | 29 45.5                                | 10 13.6                                | 49 5.4                                 |
| 15      | 25 46.7                                | 9 29.8                                 | 49 20.9                                |
| 16      | 21 47.8                                | 8 45.1                                 | 49 35.8                                |
| 17      | 17 49.1                                | 8 3.0                                  | 49 47.2                                |
| 18      | 8 13 50.3                              | 7 20.1                                 | 50 5.6                                 |
| 22      | 7 57 56.1                              | 4 40.8                                 | 50 55.1                                |
| 24      | 50 0.8                                 | 3 47.6                                 | 51 21.8                                |
| 25      | 46 3.0                                 | 3 20.4                                 | 51 31.0                                |
| 26      | 42 5.0                                 | 2 47.5                                 | 51 39.9                                |
| 27      | 38 7.4                                 | 2 20.5                                 | 51 44.9                                |
| 28      | 34 10.0                                | 2 0.3                                  | 51 51.7                                |
| 29      | 30 13.8                                | 1 40.8                                 | 52 1.8                                 |
| Nov. 2  | 7 14 24.2                              | 330 0 26.8                             | 52 26.2                                |
| 10      | 6 42 54.0                              | 329 59 41.7                            | 52 33.9                                |
| 17      | 15 27.2                                | 330 0 50.5                             | 52 8.8                                 |
| 18      | 6 11 32.7                              | 1 10.9                                 | 51 59.3                                |
| 21      | 5 59 49.0                              | 2 11.4                                 | 51 34.7                                |
| 24      | 48 6.4                                 | 3 29.6                                 | 51 6.4                                 |
| 27      | 36 25.4                                | 5 9.4                                  | 50 27.5                                |
| 28      | 32 31.7                                | 5 44.1                                 | 50 12.2                                |
| Dec. 4  | 5 9 13.8                               | 10 7.4                                 | 48 38.0                                |
| 8       | 4 53 44.2                              | 13 38.5                                | 47 19.9                                |
| 12      | 38 16.4                                | 17 37.0                                | 45 49.3                                |
| 17      | 4 18 59.5                              | 330 23 18.5.:                          | 102 43 49.6:                           |

## Transit. (Mr. George Rümker.)

| 1847.   | Hamburg M.T.                           | R.A.                                   | 1847.   | Hamburg M.T.                           | R.A.                                   |
|---------|----------------------------------------|----------------------------------------|---------|----------------------------------------|----------------------------------------|
|         | <sup>h</sup> <sup>m</sup> <sup>s</sup> | <sup>o</sup> <sup>'</sup> <sup>"</sup> |         | <sup>h</sup> <sup>m</sup> <sup>s</sup> | <sup>o</sup> <sup>'</sup> <sup>"</sup> |
| Sept. 7 | 10 58 11                               | 330 54 36.7                            | Oct. 25 | 7 46 3                                 | 330 3 21.4                             |
| 10      | 46 6                                   | 50 10.0                                | 26      | 42 5                                   | 2 46.8                                 |
| 15      | 25 58                                  | 43 0.1                                 | Nov. 2  | 7 14 24                                | 0 27.7                                 |
| 18      | 10 13 54                               | 38 58.5                                | 18      | 6 11 33                                | 1 12.4                                 |
| 26      | 9 41 45                                | 28 35.1                                | 21      | 5 59 49                                | 2 7.7                                  |
| 27      | 37 44                                  | 27 25.9                                | 27      | 36 26                                  | 5 12.6                                 |
| Oct. 4  | 9 9 42                                 | 19 32.8                                | 28      | 32 31                                  | 5 41.1                                 |
| 12      | 8 37 44                                | 11 56.1                                | Dec. 4  | 5 9 14                                 | 10 11.3                                |
| 24      | 7 50 1                                 | 330 3 50.0                             | 12      | 4 38 17                                | 330 17 41.2                            |

*Elliptic Elements.* By Professor S. C. Walker.

|                                |                 |                                 |
|--------------------------------|-----------------|---------------------------------|
| Epoch.....                     | 328° 31' 56".36 | G. M. Noon, Jan. 1, 1847        |
| Longitude Perihelion . . . . . | 48 21 2".93     | M. E. Jan. 1, 1847              |
| Ascending Node                 | 130 4 35".03    |                                 |
| Inclination .....              | 1 46 59".54     |                                 |
| Excentricity .....             | 0.00857741      |                                 |
| Mean Daily Siderial Motion     | 21".55448       | Period 164.6181 Tropical Years. |

“ On applying the perturbations computed by Professor Peirce to the true longitude and radius vector, the ephemeris affords the following comparison with direct observation :—

|      |         | R. A.<br>Obs <sup>d</sup> —Calc <sup>d</sup> . | Decl.<br>Obs <sup>d</sup> —Calc <sup>d</sup> . |
|------|---------|------------------------------------------------|------------------------------------------------|
| 1795 | May 9   | + 3".1                                         | — 0".7                                         |
| 1846 | Nov. 7  | — 2".7                                         | 1".2                                           |
| 1847 | April 6 | — 1".3                                         | 2".5                                           |
| 1847 | Aug. 22 | + 0".3                                         | — 0".1                                         |

“ A change of one year in the periodic time would vary the relative differences of the computed places for Nov. 7, 1846, and April 6, 1847, by 11".4.”

*Perturbations.*

By Professor Peirce, of the University of Cambridge, U.S.

“ The following formulæ are expressions of a first approximation to a theory of the perturbations of *Neptune* by the other planets. All the terms (as high as the first power of the excentricity of the disturbing planets) are retained, which can affect the longitude 0".01; the terms dependent on the squares of the excentricities, as well as those which depend on the excentricity of *Neptune*, are neglected. The relative inclinations of the orbits, the secular changes in the elements of the disturbing planets, and the great inequality of the motions of *Jupiter* and *Saturn*, are also neglected. Mr. S. C. Walker's elements of *Neptune* are adopted, neglecting the excentricity and assuming (for convenience of computation) a mean motion exactly half that of *Uranus*. The elements of the disturbing planets are taken from Bouvard's tables. The masses are

$$\text{Jupiter} = \frac{1}{1048}; \quad \text{Saturn} = \frac{1}{3501}; \quad \text{Uranus} = \frac{1}{24605}.$$

The last being taken from Lamont's determination. The neglected terms are so small or of so long a period, that they cannot materially interfere with the principal design of this approximation, which is that of enabling astronomers to free the observations of *Neptune* from the effects of perturbation, and thus to obtain the true elliptic elements which may be used for a complete theory of the planet. The mean longitude of each planet is denoted by its

initial letter, and the longitude of the perihelion by prefixing  $\pi$  to the symbolic letter;  $t$  is the number of Julian years after Jan. 1, 1850."

*Perturbations of True Longitude,  $v$ .*

$$\begin{aligned}
 \delta v = & - (1.87 - 0.0688 t) \sin (U - N) \\
 & + (6.55 - 0.2903 t) \cos (U - N) \\
 & - 7.40 \sin 2 (U - N) - 0.87 \cos 2 (U - N) \\
 & - 1.56 \sin 3 (U - N) - 0.10 \cos 3 (U - N) \\
 & - 0.47 \sin 4 (U - N) - 0.10 \cos 4 (U - N) \\
 & - 0.19 \sin 5 (U - N) - 0.06 \cos 5 (U - N) \\
 & - 0.08 \sin 6 (U - N) - 0.03 \cos 6 (U - N) \\
 & - 0.04 \sin 7 (U - N) - 0.02 \cos 7 (U - N) \\
 & - 0.02 \sin 8 (U - N) - 0.01 \cos 9 (U - N) \\
 & + 0.0404 t - 0.001851 t^2 + 0.0168 t \cdot \cos (N - \pi U) \\
 & + 18.35 \sin (S - N) - 0.28 \sin 2 (S - N) - 0.02 \sin 3 (S - N) \\
 & + 0.25 \sin (S - 2N + \pi S) + 0.01 \sin (S - \pi S) \\
 & + 0.36 \sin (2S - 3N + \pi S) + 0.52 \sin (2S - N - \pi S) \\
 & + 0.01 \sin (3S - 2N - \pi S) + 0.0025 t \cdot \cos (N - \pi S) \\
 & + 33.59 \sin (J - N) - 0.01 \sin 2 (J - N) \\
 & + 0.01 \sin (J - 2N + \pi J) + 0.80 \sin (2J - N - \pi J) \\
 & + 0.0035 t \cos (N - \pi J) + 0.02 \sin (E - N)
 \end{aligned}$$

*Perturbations of Radius Vector,  $r$ .*

$$\begin{aligned}
 \delta r = & 0.0000123 t + 0.01346 \\
 & + (0.00236 - 0.0000128 t) \cos (U - N) \\
 & - (0.00015 + 0.0000156 t) \sin (U - N) \\
 & + 0.00091 \cos 2 (U - N) - 0.00012 \sin 2 (U - N) \\
 & + 0.00021 \cos 3 (U - N) - 0.00005 \sin 3 (U - N) \\
 & + 0.00007 \cos 4 (U - N) - 0.00002 \sin 4 (U - N) \\
 & + 0.00006 \cos 5 (U - N) - 0.00001 \sin 5 (U - N) \\
 & + 0.00001 \cos 6 (U - N) + 0.00001 \cos 7 (U - N) \\
 & + 0.0000114 t \sin (N - \pi U) \\
 & + 0.00275 \cos (S - N) + 0.00003 \cos 2 (S - N) \\
 & + 0.00003 \cos (2S - N - \pi S) - 0.00006 \cos (N - \pi S) \\
 & + 0.0000006 t \sin (N - \pi S) \\
 & + 0.00496 \cos (J - N) + 0.00013 \cos (2J - N - \pi J) \\
 & - 0.00019 \cos (N - \pi J) + 0.0000003 t \sin (N - \pi J)
 \end{aligned}$$

"The perturbations for the following dates have been computed from the preceding formulæ, and must be added with reversed sign to the heliocentric longitudes and radii vectores deduced from observation, in order to obtain those which correspond to the pure elliptic motion."

|      |         | $\delta v.$           | $\delta r.$             |       |         | $\delta v.$           | $\delta r.$             |
|------|---------|-----------------------|-------------------------|-------|---------|-----------------------|-------------------------|
| 1795 | May 9   | +37 <sup>''</sup> .60 | +0 <sup>''</sup> .01207 | 1847. | June 1  | +30 <sup>''</sup> .65 | +0 <sup>''</sup> .01458 |
| 1846 | Sept. 1 | +32 <sup>''</sup> .00 | +0 <sup>''</sup> .01660 |       | July 1  | 30 <sup>''</sup> .23  | 0 <sup>''</sup> .1437   |
|      | Oct. 1  | 32 <sup>''</sup> .09  | 0 <sup>''</sup> .1637   |       | Aug. 1  | 29 <sup>''</sup> .76  | 0 <sup>''</sup> .1417   |
|      | Nov. 1  | 32 <sup>''</sup> .11  | 0 <sup>''</sup> .1613   |       | Sept. 1 | 29 <sup>''</sup> .24  | 0 <sup>''</sup> .1397   |
|      | Dec. 1  | 32 <sup>''</sup> .07  | 0 <sup>''</sup> .1590   |       | Oct. 1  | 28 <sup>''</sup> .67  | 0 <sup>''</sup> .1378   |
| 1847 | Jan. 1  | +31 <sup>''</sup> .97 | +0 <sup>''</sup> .01567 |       | Nov. 1  | 28 <sup>''</sup> .06  | 0 <sup>''</sup> .1360   |
|      | Feb. 1  | 31 <sup>''</sup> .82  | 0 <sup>''</sup> .1545   |       | Dec. 1  | 27 <sup>''</sup> .41  | 0 <sup>''</sup> .1343   |
|      | Mar. 1  | 31 <sup>''</sup> .61  | 0 <sup>''</sup> .1522   | 1848. | Jan. 1  | +26 <sup>''</sup> .71 | +0 <sup>''</sup> .01325 |
|      | April 1 | 31 <sup>''</sup> .34  | 0 <sup>''</sup> .1501   |       | Feb. 1  | +25 <sup>''</sup> .97 | +0 <sup>''</sup> .01308 |
|      | May 1   | +31 <sup>''</sup> .02 | +0 <sup>''</sup> .01479 |       |         |                       |                         |

## HEBE.

## Observations.

WASHINGTON.      Equatoreal.      (Lieut. M. F. Maury, U.S.N.)

|         | Washington M.T. |                                       |       | R.A. |    |       | N.P.D. |      |                | Stars of Comp. | Mags. noted. |
|---------|-----------------|---------------------------------------|-------|------|----|-------|--------|------|----------------|----------------|--------------|
| 1847.   | h               | m                                     | s     | h    | m  | s     | °      | '    | "              |                |              |
| Aug. 10 | 9               | 33                                    | 25    | 16   | 55 | 17.28 | 98     | 59   | 3.1            | B. xvii. 83    |              |
|         | 11              | 8                                     | 17 39 |      | 55 | 28.87 | 99     | 7    | 44.6           | —              | 83           |
|         | 18              | 9                                     | 1 54  |      | 57 | 39.43 | 100    | 12   | 7.1            | —              | 3 9; 9; 9.10 |
|         | 19              | 8                                     | 44 14 |      | 58 | 4.09  | 21     | 7.9  | —              | 3              | 9.10; 9.10   |
|         | 20              | 9                                     | 7 3   | 16   | 58 | 31.30 | 100    | 30   | 21.4           | —              | 3 9.10       |
|         | 25              | 10                                    | 25 9  | 17   | 1  | 11.74 | 101    | 16   | 24.8           | —              | 18 9.10; 9   |
|         | 29              | Star of Comparison not in Catalogues. |       |      |    |       |        |      |                |                | 11.12        |
|         | 30              | 7                                     | 49 59 |      | 4  | 23.83 | 102    | 0    | 5.6            | B. xvi. 1139   | 9.10         |
| Sept. 1 | 9               | 11                                    | 12    |      | 5  | 55.41 | 18     | 18.8 | xvii. 155, 179 | 11             |              |
|         | 3               | 8                                     | 7 39  |      | 7  | 29.08 | 35     | 23.5 | —              | 168            | 10; 10; 10   |
|         | 4               | 7                                     | 42 9  |      | 8  | 16.72 | 102    | 43   | 57.9           | B.A.C. 5845    | 10           |
|         | 6               | 8                                     | 11 4  |      | 10 | 1.28  | 103    | 1    | 18.7           | —              | 10.11        |
|         | 10              | Star of comparison not in Catalogues. |       |      |    |       |        |      |                |                | 11           |
|         | 13              | 7                                     | 59 54 |      | 16 | 44.81 | 104    | 0    | 2.8            | B. xvii. 366   | 10.11        |
|         | 14              | 8                                     | 55 26 |      | 17 | 50.44 | 8      | 29.9 | —              | —              | 11           |
|         | 15              | 8                                     | 13 52 |      | 18 | 52.86 | 16     | 16.8 | —              | 397            | 10.11        |
|         | 16              | 7                                     | 37 20 |      | 19 | 56.47 | 24     | 6.1  | —              | 462            | 10.11        |
|         | 17              | 7                                     | 54 35 |      | 21 | 3.82  | 32     | 13.1 | —              | 392            | 11.12        |
|         | 20              | 7                                     | 29 20 |      | 24 | 31.04 | 104    | 55   | 30.8           | B.A.C. 5949    | 11           |
|         | 21              | 7                                     | 36 33 |      | 25 | 41.69 | 105    | 3    | 10.9           | —              | 10; 10.11    |
|         | 22              | 7                                     | 33 50 | 17   | 26 | 54.46 | 105    | 10   | 42.2           | —              | 11.12        |

“These observations are corrected for refraction *only*.”

“The change of magnitude did not, for some time, suggest to me the idea of a brighter and a darker side to the planet. The first remark to this effect is